



Corridor Program

Congestion Relief & Bus Rapid Transit Projects

APPENDIX V

Test Methods Density Differentials

**I-405, SR520 to SR522 Stage 1
(Kirkland Stage 1)**

**Request For Proposal
July 15, 2005**



**Washington State
Department of Transportation**

Determination of Mat Density Differentials Using the Nuclear Density Gauge

INTRODUCTION

This test method explains how to locate and test for cyclic density. The Design-Builder's field personnel are to systematically measure the locations where the mat density may vary due to temperature differentials or aggregate segregation. The described test method will identify density variations due to both causes.

1. GENERAL SCOPE

- a. Temperature differentials consist of any difference in temperature that is 25°F or greater that has not been on the roadway more than 1 minute and has not been rolled. Only temperature differentials located within the compaction lot should be marked and tested for density.
- b. For the purposes of this test method, aggregate segregation consists of an area that has a significantly different texture than the surrounding material.
- c. A systematic density reading shall be performed on locations where a temperature differential exists or where the mat has a significantly different texture.
- d. Asphalt concrete density measurements are made using a nuclear moisture density gauge in direct transmission mode.
- e. A density measurement shall be the average of two density readings taken in the same location at 90 degrees from each other. The readings shall agree within 3.0 lbs/ft³ of each other.
- f. Gauge-core correlation is required for the systematic density testing.
- g. Normal Quality Assurance Testing will be performed throughout the entire job in addition to any systematic density readings.

2. EQUIPMENT

- a. ThermaCAM E65 infrared camera (or approved equal) OR a handheld non-contact infrared thermometer (features for the non-contact thermometer should include continuous reading, minimum, maximum, and average readings, laser sighting, and a minimum distance to spot size ratio (D:S) of 30:1. The Raytek Raynger ST 60 ProPlus or ST 80 ProPlus are examples of handhelds with the needed features).
- b. Nuclear density gauge and standardizing block (reference standard).
- c. Tape measure.
- d. A can of spray paint for marking test locations.
- e. Required report form.

3. GAUGE CALIBRATION

- a. Follow the gauge calibration as outlined in the Operator's Manual.

4. TEMPERATURE CRITERIA

- a. If $\Delta T \geq 25^{\circ}\text{F}$ – Requires systematic density test
- b. If $\Delta T < 25^{\circ}\text{F}$ – No need to perform testing unless an area with a significantly different texture exists

5. USE OF INFRARED CAMERA

- a. View at least five consecutive truckloads of mix (as described in steps b, c, d, e, and f) being laid on the mat and observe the location and temperature of any cool spots within the compaction lot. These observations should allow the operator to become familiar with the location and extent of the temperature differentials, if any, and if the temperature differentials are occurring in a cyclic manner.
- b. Viewing should occur from the side of the mat approximately 15 to 20 feet back from the paver looking toward the paver.
- c. The camera should be focused on the freshly laid mat and the temperature range should be adjusted to include the high and low temperatures.
- d. One truckload of mix consists of when the truck starts to dump into the paver or material transfer device until another truck starts to dump.
- e. The “spot” function on the camera should be used to obtain the temperature of the cool area and the surrounding mat to assess the temperature differential.
- f. Only temperature differentials located within the compaction lot should be marked for density testing.
- g. If the temperature differential is 25°F or more, locate the approximate center of the temperature differential area with the camera. The offset is from the center of the temperature differential area to the edge of the lane. Mark the location to be tested for systematic density by placing a paint mark at the edge of the lane corresponding to the center of the temperature differential. Record the temperature differential, offset, and station as shown in Figure 1.
- h. If the temperature differential is less than 25°F , there is no need to mark the location unless an area within the mat has a significantly different texture. If testing is performed because of a significantly different textured area, locate the center of the affected area and mark the location as described in step g and as shown in Figure 1 with an (S) after the temperature differential [23°F (S)/ $8'5''/53+85$].

6. USE OF HANDHELD NONCONTACT INFRARED THERMOMETER

- a. View at least five consecutive truckloads of mix (as described in steps b, c, d, e, and f) being laid on the mat at varying offsets and observe the location and temperature of any cool spots within the compaction lot. These observations should allow the operator to become familiar with the location and extent of the temperature differentials, if any, and if the temperature differentials are occurring in a cyclic manner.

- b. Begin the longitudinal scan when a truck starts to dump into the paver or material transfer device and continue until the paver stops (discontinuous mix delivery) or until another truck starts to dump (continuous mix delivery).
- c. To perform the longitudinal scan, stand at the edge of the paving lane about 5 to 10 feet back from the paver. Scan the mat with the handheld non-contact thermometer continuously in a longitudinal manner by walking behind the paver in the direction of paving, staying the same distance away from the paver for one truckload of hot mix. The offset for the longitudinal profile should be anywhere from 18 inches from the edge to no more than half the width of the mat. (The need to vary the longitudinal offset will be necessary to get an accurate representation of the whole mat.) Scanning the temperatures for the other half of the mat should be performed from the other side of the paved lane. Typically, temperature differentials or segregation at the beginning or end of a truckload can be captured with the longitudinal scan.
- d. Perform a transverse scan after completion of the longitudinal scan, making sure to scan the entire width of the mat excluding the outer 18 inches on each side. It should be performed approximately 5 to 10 feet behind the screed (to check for streaking of the mat). Typically, streaking caused by temperature differentials or segregation will be captured by the transverse scan.
- e. The temperature scan can be stopped as soon as a temperature differential greater than 25°F has been located.
- f. Only temperature differentials located within the compaction lot should be marked for density testing.
- g. If the temperature differential is 25°F or more, locate the approximate center of the temperature differential area by scanning that specified location. The offset is from the center of the temperature differential area to the edge of the lane. Mark the location to be tested for systematic density by placing a paint mark at the edge of the lane corresponding to the center of the temperature differential. Record the temperature differential, offset, and station as shown in Figure 1.
- h. If the temperature differential is less than 25°F, there is no need to mark the location unless an area within the mat has a significantly different texture. If testing is performed because of a significantly different textured area, locate the center of the affected area and mark the location as described in step g and as shown in Figure 1 with an (S) after the temperature differential [23°F (S)/8'5"/53+85].

7. SYSTEMATIC DENSITY PROCEDURE

- a. Testing shall be performed after the Design-Builder has finished compaction of the mat.
- b. Locate the mark (Figure 1) and record the information as listed.
- c. The probe of the gauge shall be placed at the offset listed and perform the testing according to WSDOT FOP for WAQTC TM 8 (direct transmission mode).
- d. Record the data on the Asphalt Concrete Pavement Compaction Report for Cyclic Density Form.

8. NUMBER AND LOCATION OF TEMPERATURE PROFILES AND SYSTEMATIC DENSITY TESTS

- a. If any temperature differentials were found in the initial assessment of paving operations (as described in 5a or 6a), the Quality Organization tester shall take at least one temperature profile for every 5 trucks delivered to the paving operation.
- b. If the operation is not producing temperature differentials greater than 25°F in a cyclic pattern or the Quality Organization tester is not able to find 4 or more locations to be tested per compaction lot, the testing frequency can be reduced, but should be checked randomly throughout the day and the results recorded.
- c. If any significant equipment or weather changes occur, temperature profiles should be performed to determine if the new operation is capable of producing uniform mat temperatures.
- d. No temperature profiles shall be performed within the first or last 25 tons of production each day or within 25 feet of any transverse joint.
- e. Systematic density testing shall be performed on any location marked for testing.

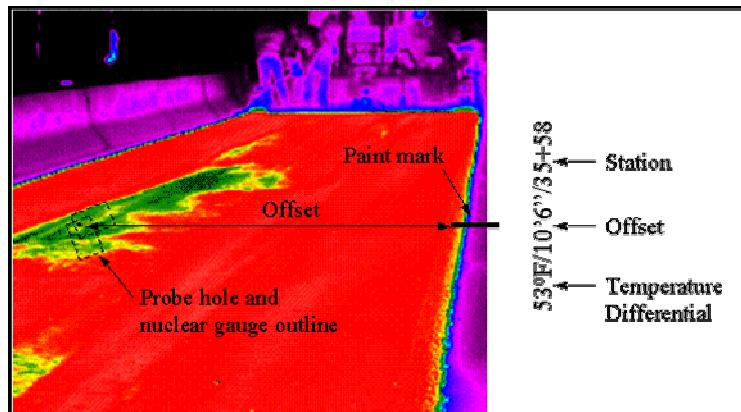


Figure 1
Marking location of temperature differential.